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13. ABSTRACT ***(Maximum 200 Words)***

The Distributed Interactive Fire Mission (DIFM) Concept Evaluation Program (CEP) was an experimental exercise conducted at the Mounted Warfare Test Bed (MWTB) at Fort Knox, KY from January 19 to 29, 1999. The experiment was performed as Delivery Order (DO) #0098 under the Lockheed Martin Advanced Distributed Simulation Technology II (ADST II) Contract administered by the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM).

The Mounted Maneuver Battle Lab (MMBL), Fort Knox, KY sponsored the experiment. The experiment utilized a synthetic environment that employed virtual simulations to depict an Armor Platoon executing six basic platoon-level scenarios in realistic combat situations in various experimental configurations. The scenarios were executed on the Synthetic Theatre of War – Europe (STOW-E) terrain database using Movement to Contact vignettes. These scenarios were designed into a twenty-eight trail matrix to induce the platoon leader to make tactical decisions which affected battle outcomes.

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EXECUTIVE SUMMARY

The Distributed Interactive Fire Mission (DIFM) Concept Evaluation Program (CEP) was an experimental exercise conducted at the Mounted Warfare Test Bed (MWTB) at Fort Knox, KY from January 19 to 29, 1999. The experiment was performed as Delivery Order (DO) #0098 under the Lockheed Martin Advanced Distributed Simulation Technology II (ADST II) Contract administered by the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM).

The Mounted Maneuver Battle Lab (MMBL), Fort Knox, KY sponsored the experiment. The experiment utilized a synthetic environment that employed virtual simulations to depict an Armor Platoon executing six basic platoon-level scenarios in realistic combat situations in various experimental configurations. The scenarios were executed on the Synthetic Theatre of War – Europe (STOW-E) terrain database using Movement to Contact vignettes. These scenarios were designed into a twenty-eight trail matrix to induce the platoon leader to make tactical decisions which affected battle outcomes. The objectives of the effort were:

a) To determine the operational effectiveness of an Armor Platoon equipped with alternative DIFM functionality applications during threat engagements in a Force XXI or Army After Next (AAN) tactical environment.

b) To identify software requirements essential to implement DIFM alternatives at Platoon level operations.

c) To serve as a foundation for subsequent evaluation of DIFM growth to support Battalion level, Beyond Line-Of-Sight (BLOS), target intensive, and conceivably combined arms fire distribution.

DIFM is a concept describing integrated multi-agent (distributed) automated fire control systems capable of accepting target information from multiple sources, determining available firing platforms (based on location, activity, and obstacle noninterference), tasking unencumbered shooters, passing fire solution data to assigned platforms, displaying shooter target acquisition indicators to facilitate search and rapid engagement procedures, and consequently optimize shooter survivability. The objective system will encompass computation, display, communication functionality, and will have the capacity to: a) automatically assign search sectors to all shooters, prioritize targets, cue incoming firing data, cue engagement area limits (in the sight reticule), cue no-responsibility (other-assigned) targets for individual shooters, and automatically locate and slew onto assigned targets at the individual shooter level for target assignment functions; and b) determine kill zones and optimal firing positions (through terrain analysis) for subordinate units alerted to maneuvering opponents, project sector entry points of targets for vehicle commanders' early engagement, track friendly forces for improved identification, and prioritize targets for course-of-action determination in a planning context. Integration with programmed Force XXI Battle Command Brigade and Below (FBCB2) functionality is anticipated. On implementation, noted functionality is expected to enhance target assignment efficiency by eliminating extended sector search times and reducing required time for manual target assignment through Frequency Modulation (FM) voice radio. The system also is estimated to support immediate application of individual firing platforms for massing of direct fires on single or multiple targets.

The DIFM CEP experiment was conducted at the Mounted Warfare Test Bed (MWTB), Fort Knox, KY. The effort employed a combination of existing MWTB assets, such as M1A2 manned simulators and Modular Semi-Automated Forces (ModSAF), as well as a version of the existing Rotorcraft Pilot's Associate (RPA) simulation, modified for ground (tank) combat use.

Development of the software modifications and the initial integration of software models were conducted at the Lockheed Martin Federal Systems (LMFS) facility in Owego, NY from September 29, 1998 to January 4, 1999. The final integration phase was completed at the MWTB from January 6 to 18, 1999.

In accordance with the Government Statement of Work, the experiment's test trial window was two (2) weeks. This two week period included time to execute the trial run matrix and additional time scheduled for make-up of non-validated runs, if required.

The entire trial run matrix was executed within the allocated two weeks with no additional time required for make-up of non-validated runs. As a result, a portion of the second week was made available for additional excursion runs.

In accordance with the Government SOW, this Final Report includes a description of the experiment, its conditions and conduct, and lessons learned. This report addresses the interconnectivity of simulation systems, modifications to both ModSAF and the manned simulators, and the integration of Government Furnished software models. This report does not include discussion of data analysis nor conclusions as to whether the customer(s) achieved their objectives of the experiment.

1. INTRODUCTION

1.1 Purpose

The purpose of this final report is to document the ADST II effort which supported DIFM. This report includes a full description of the experiment, its conditions, and lessons learned.

1.2 Contract Overview

The Distributed Interactive Fire Mission (DIFM) Concept Evaluation Program (CEP) was an experimental exercise conducted at the Mounted Warfare Test Bed (MWTB) at Fort Knox, KY from January 19 to 29, 1999. The experiment was performed as Delivery Order (DO) #0098 under the Lockheed Martin Advanced Distributed Simulation Technology II (ADST II) Contract administered by the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM). The Mounted Maneuver Battle Lab (MMBL), Fort Knox, KY sponsored the experiment.

1.3 Experiment Overview.

The DIFM concept arose from a need for superior target sorting and fire distribution capabilities as advanced munitions and commanders' increased battlespace responsibilities were projected for the emerging battlefield. Given expected increases in operating tempo, the ability to rapidly and accurately sort targets and assign fire missions to intermittently available (due to prior fire missions or ammunition availability) and generally moving firing platforms was recognized as a critical requirement to facilitate the required performance on the technology-saturated battlefield. Although "end functionality" to manage the task was identified in the Force XXI Battle Command Brigade and Below (FBCB2) User Functional Description (UFD), details of serial functionality performance and functionality distribution in an operational context, and the operational effectiveness resulting therefrom, remained sketchy and unconfirmed. Therefore, an ongoing assessment of alternative functionality applications and their location was prescribed for further definition of the capability and force integration characteristics necessary to implement DIFM system integration for maximum tactical benefit.

DIFM is a concept describing integrated multi-agent (distributed) automated fire control systems capable of accepting target information from multiple sources, determining available firing platforms (based on location, activity, and obstacle noninterference), tasking unencumbered shooters, passing fire solution data to assigned platforms, displaying shooter target acquisition indicators to facilitate search and rapid engagement procedures, and consequently optimize shooter survivability. The objective system will encompass computation, display, communication functionality, and will have the capacity to: a) automatically assign search sectors to all shooters, prioritize targets, cue incoming firing data, cue engagement area limits (in the sight reticule), cue no-responsibility (other-assigned) targets for individual shooters, and automatically locate and slew onto assigned targets at the individual shooter level for target assignment functions; and b) determine kill zones and optimal firing positions (through terrain analysis) for subordinate units alerted to maneuvering opponents, project sector entry points of targets for vehicle commanders' early engagement, track friendly forces for improved identification, and prioritize targets for course-of-action determination, in a planning context. Integration with programmed FBCB2 functionality is anticipated. On implementation, noted functionality is expected to enhance target assignment efficiency by eliminating extended sector search times and reducing required time for manual target assignment through FM voice radio. The system also is estimated to support immediate application of individual firing platforms for massing of direct fires on single or multiple targets.

The DIFM CEP experiment was conducted at the Mounted Warfare Test Bed (MWTB), Fort Knox, KY. The effort employed a combination of existing MWTB assets, such as M1A2 manned simulators and Modular Semi-Automated Forces (ModSAF), as well as a version of the existing Rotorcraft Pilot's Associate (RPA) simulation, modified for ground (tank) combat use.

1.4 Technical Overview

The technical approach to the DIFM experiment involved the initial modification of software and the initial integration of software models at the LMFS facility in Owego, NY from September 29, 1998 to January 4, 1999. During this initial phase two Technical Interchange Meetings (TIMs) were conducted at the Owego, NY facility and at the MWTB. The purpose of the TIMs was to assess the development efforts to date and obtain customer approval and additional guidance. Upon completion of the initial software development, the software and its associated hardware were shipped and reinstalled at the MWTB. At the MWTB it took ten days to complete the on-site integration. Once the synthetic environment functional tests were completed, the engineers conducted troop training and a Pilot Test. A Test Readiness Review (TRR) was held on January 15, 1999. At the TRR permission was given to freeze the software configuration and approval was given to start the experiment, which began on January 19, 1999. The actual experiment period lasted two weeks during which 28 different iterations were executed using six basic scenarios. The trial matrix was completed ahead of schedule and the additional time was used to conduct excursion runs.

2. Applicable Documents

2.1 Government

-ADST II Work Statement for Distributed Interactive Fire Mission (DIFM) Concept Evaluation Program (CEP), August 25, 1998, AMSTI-98-WO68, Version 1.0

2.2 Non-Government

- None

3. System Description

3.1 System Configuration and Layout

The Mounted Warfare Test Bed at Fort Knox, KY, contains a variety of vehicle simulators, networks, Semi-Automated Forces (SAF) capabilities, displays for monitoring the battlefield, utilities to facilitate exercises, automated data collection capabilities, and data reduction and analysis subsystems. The MWTB simulation and support platforms used for DIFM are depicted in Figure 1.

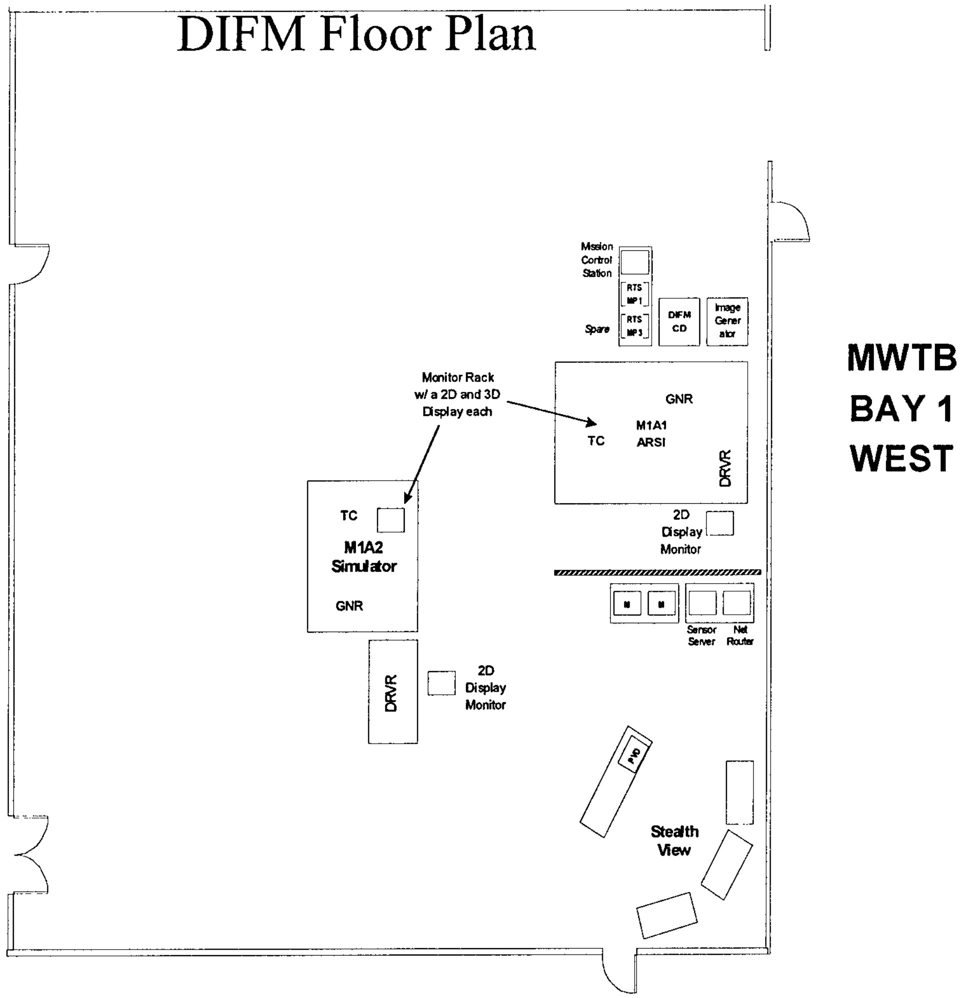

Figure 1 DIFM Floor Plan

The experiment was conducted using assets interconnected on Ethernet Local Area Networks (LANs) via thin net cable. Simulation assets used Distributed Interactive Simulation (DIS) 2.03 protocol. Table 1 lists assets used at the MWTB.

ADST II ASSET	PURPOSE	PROTOCOL
Modified M1A2 Simulator	M1A2 Simulator for Tank Platoon Sergeant	DIS
Reconfigurable Simulator	M1A2 RC Tank For Platoon Leader	DIS
Stealth	Battlefield Display for observation of the battlefield	DIS
ModSAF Workstations	Semi-Automated Forces for OPFOR, & two BLUFOR M1A2 Tanks	DIS
Plan View Display	Terrain Map of the battlefield for Exercise Control	DIS
Data Loggers	Record of DIS PDUs for Data Collection & Analysis	DIS
DIS Time Stamper	Time Stamp of DIS PDUs for Data Collection & Analysis	DIS

Table 1 MWTB Assets

3.2 Description of System Components

This section discusses the description, functionality and operation of the system components, which includes the Government Furnished Equipment (GFE) models and their integration with the hardware at the MWTB.

3.2.1 M1A2 Simulator

One M1A2 simulator was used for DIFM. The simulator represented the Tank Platoon Sergeant's tank as part of an Armor Platoon. The simulator was modified to replicate the DIFM hardware. The Tactical Display was mounted to the left of the Tank Commander (TC) in the manned simulator. It provided the commander with a color map showing accurate terrain profile and route information data, timely Platoon member locations, threat warnings, and map overlays.

3.2.2 Reconfigurable Simulator

The Platoon Leader used a reconfigurable simulator. The ARPA Reconfigurable Simulator Initiative (ARSI) Simulator was configured to replicate the Platoon Leader's M1A2 Tank. This vehicle was configured with a driver in the hull and with a crew of two in the crew compartment and turret. This configuration allowed the Platoon Leader to be the tank commander and the other crew members functioned as the gunner and driver. Additionally, a simulated open hatch view was provided for the commander on top of the simulator via three overhead projectors and screens.

3.2.3 Commander's Decision Aid

The Commander's Decision Aid (DA) was a version of the Rotorcraft Pilot's Associate Decision Aiding System, modified for ground (tank) combat. The DA consisted of software executing in a Real-Time Symmetric Multiprocessor (RTSMP) computer. The RTSMP, developed for RPA, consists of eight 150MHz PowerPC processors and both local and global memory. This was a LMFS asset and did not belong to the MWTB. The primary functions provided by the DA were:

a. Common Relevant Picture (CRP) - The DA provided a CRP of the battlespace, superimposing the location and type of all known enemy and friendly units on plan and perspective digital maps. This picture also depicted the commander's battle graphics (phase lines, zone boundaries, engagement areas, battle positions, routes and scan sectors.)

b. Mission Replanner - Upon receipt of a change of mission message, the DA recommended a new mission plan to the crew. The mission plan included battle positions and routes.

c. Scan Sectors - The DA allowed the battle commander to "draw" scan sectors for each teammate and when completed assign and distribute them to the team.

d. Battlefield Assessor - DA continually monitored the battlefield situation. Whenever changes in the battlefield situation warranted modifications to the route plan, appropriate plan modifications were recommended to the crew.

3.2.4 ModSAF Operations

ModSAF version 3.0 was used for DIFM. ModSAF was used for Blue Force (BLUFOR) round-out and Opposing Force (OPFOR). BLUFOR ModSAF provided the two additional tanks required to round-out the Armor Platoon. OPFOR were provided in a configuration of a Motorized Rifle Company to complete the scenario requirements.

3.2.5 Data Logger

The Data Logger is an ADST II asset that captures the network traffic and places the data packets on a disk or tape file. The Data Logger performs the following functions:

a. Packet Recording - Receives packets from the DIS network, time stamps and then writes to a disk or tape.

b. Packet Playback - Packets from a recorded exercise can be transmitted in real time or faster than real time. The Data Logger can also suspend playback (freeze time) and skip backward or forward to a designated point in time. The logger can be controlled directly from the keyboard or remotely from the Plan View Display (PVD). Playback is visible to any device on the network (PVD, Stealth Vehicle, a vehicle simulator, etc.).

c. Copying or Converting - Files are copied to another file, which can be on the same or a different medium; and files from the older version of the Data Logger can be converted to a format compatible with the current version of the Data Logger.

For the exercise, two data loggers were employed to capture the exercise. The two data loggers were placed on the DIS net to capture all DIS PDUs for analysis. These two loggers used Sun IPX systems with 48 MB RAM, 1 GB Hard drive, utilizing the Sun OS 4.1.3 operating system. One data logger was designated as a back up and was not needed.

3.2.6 Sensor Server

The sensor server was a SUN Sparc 20 workstation. It was running modified ModSAF 3.0 software that would receive DIS 2.03 data packets on User Datagram Protocol (UDP) port 3000 (real world) and pass them to UDP port 3010 (sensed world) if they were friendly entities or enemy entities that had been sensed by blue intelligence. This provided the ability to take a "standard" simulation tool, such as a Stealth or ModSAF PVD, and use it as a more enhanced C2 system, displaying Blue Forces (BLUFOR) Situation Awareness (SA) as well as sensed/detected OPFOR. Real world and sensed world used the same physical network.

3.2.7 Network Router

The Network Router is an application that allows different subnets to be joined according to rules appropriate to the experiment. The DIFM experiment called for Scan Sector Limit Indicators (LIs) that are visible from the manned simulators. These LIs provide an indication to the simulator's crew of the commander's desired scan limits. Each simulator's LIs should only be visible from that simulator.

For the DIFM experiment, the Network Router joined the following four subnets:

a. Overall simulation network (port 3000). This network contains Protocol Data Units (PDUs) for all simulated vehicles. It does not contain any PDUs from Posts. No simulations are directly attached to this network.

b. M1A2 network (port 3081). This network contains contains PDUs for all simulated vehicles. It also contains the LIs intended for the M1A2 manned simulator. The M1A2 simulator is directly attached to this network.

c. ARSI network (port 3095). This network contains PDUs for all simulated vehicles. It also contains the LIs intended for the ARSI manned simulator. The ARSI simulator is directly attached to this network.

d. ModSAF network (port 3033). This network contains PDUs for all simulated vehicles. It also contains the LIs intended for any ModSAF vehicle. The ModSAFs are directly attached to this network.

The process starts when the DIFM sends a Scan Sector PDU, which is defined as:

```
typedef struct {
  DIS203_PDU_HEADER_RECORD           pdu_header;
  DIS203_ENTITY_ID_RECORD            sender_id;
  DIS203_ENTITY_ID_RECORD            target_id;
  uint32              state;
  uint32              pad;
  DIS203_WORLD_COORDINATES_RECORD    origin;
  DIS203_WORLD_COORDINATES_RECORD    left_ray;
  DIS203_WORLD_COORDINATES_RECORD    right_ray;
  float32             field_of_view;
  float32             heading;
  float32             range;
} DIS203_SCAN_SECTOR_PDU;
#define DIS203_SCAN_SECTOR_PDU_KIND    186
#define SCAN_SECTOR_STATE_ACTIVE     0
#define SCAN_SECTOR_STATE_INACTIVE    1
```

The important fields are target_id (the simulator that should see the LIs), and the origin, left_ray, and right_ray locations. When the Network Router receives a Scan Sector PDU, it calculates LI locations using the origin, left_ray, and right_ray locations. The left LI will be 200 meters from the origin along the origin-left_ray vector. If there is no intervisibility to that location, a new location closest to

the origin will be determined, until intervisibility exists. The process is repeated for the right LI. Entity_State PDUs for the LIs are then transmitted on the appropriate subnet. The LIs enumeration is that of a Line Pair Target Board. Entity_State PDUs will be periodically generated for each LI until a Scan Sector PDU is received with the state field equal to SCAN_SECTOR_STATE_INACTIVE. The network diagram is shown in figure 2.

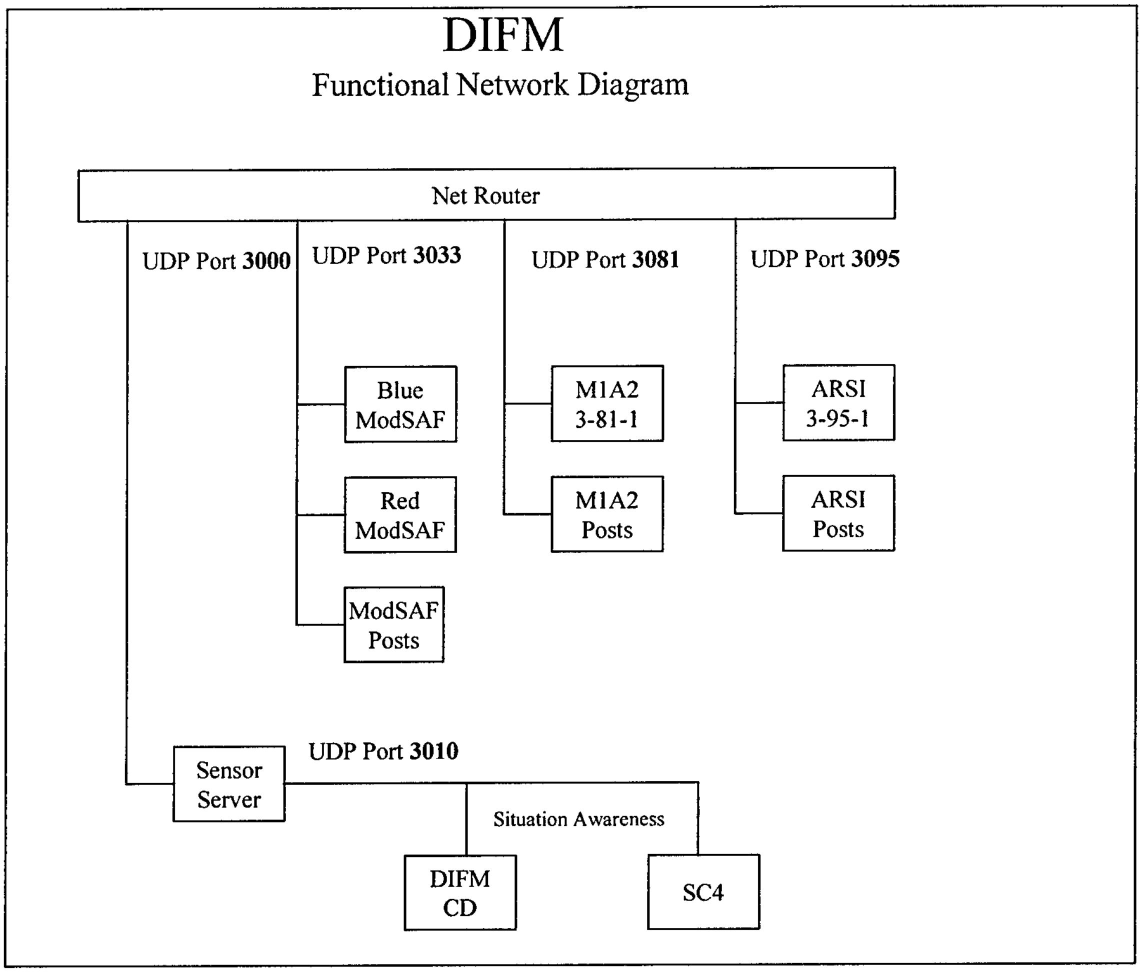

Figure 2. Network Diagram

3.2.8 Time Stamper

The MWTB provided a Time Stamper, which consisted of a video time code generator. This time code generator produced time data in days, since 1 January, in hour/min/sec format. It also ran on an IBM-compatible Personal Computer (PC). The PC was programmed to read the video time code, convert the time data, and then generate a Time PDU which was then issued on the DIS network each second. This provided the real world clock time on the logged data to assist in subsequent analyses.

3.2.9 Stealth System

The ADST II Stealth gives the Observer/Controller (O/C) personnel a "window" into the virtual battlefield allowing them to make covert observations of the action occurring during the scenario. In addition, through the use of the data logger, the Stealth gives observers and analysts an After Action Review(AAR) capability. The Stealth is a visual display platform that consists of a PVD, various input devices, and three video displays that provide the operator with a panoramic, 3D view of the battlefield.

The Stealth permits the controller to fly around the virtual battlefield and view the simulation without interfering with the action. The features of the Stealth allow the observer to survey the virtual battlefield from a variety of different perspectives, including:

a. Tethered View - Allows the user to attach unnoticed to any vehicle on the virtual battlefield.

b. Mimic View - Places the user in any vehicle on the virtual battlefield and provides the same view as the vehicle commander.

c. Orbit View - Allows the operator to remain attached to any vehicle on the virtual battlefield and to rotate 360° about that vehicle, while still maintaining the vehicle as a center point of view.

d. Free Fly Mode - Permits independent 3-D movement anywhere in the virtual battlefield.

3.2.10 Database and Scenario Development

The existing ADST II STOW-E terrain database was used to support the experiment. The database was 50 Km by 50 Km and was used with sunshine and rain weather conditions.

A series of six test scenarios and one training scenario were developed to support DIFM. Each scenario contained four vignettes that depicted an Armor Platoon conducting Movement to Contact (MTC) tasks. The scenarios included Operations Orders (OPORD), Fragmentary Orders (FRAGO) and overlays to support the mission. The orders and overlays were developed by the Mounted Maneuver Battle Lab and Lockheed Martin Service Group (LMSG) MWTB personnel.

4. Conduct of The Experiment

4.1 Troop Training

In order to get the maximum benefit from the Pilot Test, a three day period of time was set aside for troop training to bring the soldiers and Research Assistants up to a level of confidence on the systems prior to the Pilot Test. This troop training was conducted at the MWTB from January 13-15, 1999.

4.2 Pilot Test

The Pilot Test was conducted at the MWTB on January 15, 1999. During this time, the soldiers used the skills acquired in troop training to conduct tactical operations in a scenario specially designed to stress the systems and the soldier's skills. During this time special attention was given to focus on technical anomalies that appeared. One anomaly appeared during the Pilot Test that related to the pan or edit function on the Platoon Leader's DIFM display. It was noticed that when the Platoon Leader would attempt to pan or edit his screen that the Platoon Sergeant would have no control over his display due to the repeater link.

Following the Pilot Test, a time was set aside to conduct a TRR to discuss the status of the system. The TRR was held on January 15, 1999. At the TRR two issues emerged. The first issue was to develop a software modification that allowed the Platoon Leader edit function to be done independently of the other vehicle. A software modification was developed and in place within two hours after the TRR. The second issue was a recommendation by the LMFS engineers to delay the start of the experiment by one day in order to verify the mission planning files and make adjustments to align the Universal Transverse Mercator (UTM) coordinates with the latitude and longitude locations. This delay of the experiment for one day to verify the mission planning files had no impact on the schedule.

4.3 Experiment and Trial Runs

The trial runs for the experiment began on January 19, 1999. The complete trial matrix for a total of 28 runs was completed ahead of schedule and the remaining time was used for additional excursion runs. The experimental unit was a Tank Platoon. Manned entities were one Platoon Leader and Platoon Sergeant. The remainder of the Platoon was provided by ModSAF. Table 2 defines the system configuration and scenario used in each trial.

DIFM EXPERIMENT MATRIX

Study Variables:

RPA	After-FRAGO Route Distance	Route Terrain Character(RTC)	# Enroute FRAGOs	3D Presentation	BP Terrain Character
Yes	Short(5k)	Simple	1	Lateral	Simple
No	Med (10k)	Rough	2	Inset	Rough
	Long (15k)	No			

Case	Player	RPA	RTC	Distance	3D	#FRAGO	BP
1	1	No	Simple	Short	No	1	Simple
2	1	No	Simple	Long	No	1	Simple
3	1	No	Rough	Short	No	1	Simple
4	1	No	Rough	Long	No	1	Simple
5	1	No	Rough	Long	No	1	Rough
6	1	Yes	Simple	Short	Lateral	1	Simple
7	1	Yes	Simple	Med	Lateral	1	Simple
8	1	Yes	Simple	Long	Lateral	1	Simple
9	1	Yes	Rough	Short	Lateral	1	Simple
10	1	Yes	Rough	Med	Lateral	1	Simple
11	1	Yes	Rough	Long	Lateral	1	Simple
12	1	Yes	Simple	Med	Lateral	2	Simple
13	1	Yes	Rough	Med	Lateral	2	Simple
14	1	Yes	Simple	Med	Insert	1	Simple
15	1	Yes	Rough	Med	Insert	1	Simple
16	1	Yes	Simple	Med	Insert	1	Rough
17	1	Yes	Rough	Med	Insert	1	Rough
18	1	Yes	Simple	Med	No	1	Simple
19	1	Yes	Rough	Med	No	1	Simple
20	1	Yes	Simple	Med	No	1	Rough
21	2	No	Simple	Long	No	1	Simple
22	2	No	Rough	Long	No	1	Simple

23	2	No	Rough	Long	No	1	Rough
24*	2	Yes	Simple	Short	Lateral	1	Simple
25	2	Yes	Simple	Long	Lateral	1	Simple
26*	2	Yes	Rough	Short	Insert	1	Simple
27	2	Yes	Rough	Long	Insert	1	Simple
28	2	Yes	Rough	Long	Lateral	1	Rough

* indicates delete if time restrictions require.

Table 2 Experiment Matrix

5. Observations and Lessons Learned

- **Observation #1**

Creating required databases for the STOW-E operating area consumed greater than planned resources (approximately 300 engineering hours) and even when completed problems remained.

- **Discussion #1**

The RPA software, which was extended to provide the DIFM DA function, utilizes many terrain-referenced databases. As designed, these databases can all be created from standard Defense Mapping Agency (DMA) products. The MMBL simulation environment for DIFM utilized data in a format called Compact Terrain Database (CTDB). Because of differences between the simulated STOW-E world and the real STOW-E world in Europe (a common occurrence) an additional requirement was developed to create the required terrain-referenced databases for use in the experiment from the CTDB. This processing resulted in correlation differences between the DIFM DA system and the simulated world in the MMBL. For this experiment most problems were resolved by building an offset function into the DA system and then manually "tuning" until correlation was acceptable. However, the resulting visual correlation was not perfect and significant differences remained in the UTM and Latitude/Longitude (LAT/LONG) read-outs of the two systems. (Preventing the Battle Commander from issuing orders in UTM or LAT / LONG.)

- **Lesson Learned #1**

Prior to conducting follow-on experiment efforts to resolve these differences need to be undertaken. The MMBL should create a database repository that retains all required correlated databases for their area of operations. Thus, preventing future experimenters from re-generating what DIFM already created.

- **Observation #2**

The Route Planner developed for Army Aviation operations can be tuned to generate acceptable routes for ground (tank) combat.

- **Discussion #2**

The RPA route planner was adapted to create routes for ground vehicles by tuning weights in data files. The algorithm itself was not modified. Examples of tuning performed included setting planning altitudes to on the ground and favoring roads or other terrain that could be traversed by ground vehicles. The resulting routes were, for the most part, acceptable to the tank drivers and commanders. The one exception was that since terrain slope was not directly considered some routes climbed grades that were too steep.

- **Lesson Learned #2**

With only the tuning of parameters in data files acceptable plans were recommended by the DA. However, follow-on work should consider adding a terrain slope term the route planning algorithm.

- **Observation #3**

Parameter tuning alone was, in most cases, not adequate for the DA software to recommend acceptable battle positions to the crew.

- **Discussion #3.**

The RPA battle position recommendation software, developed on RPA to recommend positions for helicopters, was modified for ground operations by changing parameters in data files. The algorithm was not modified. The resulting positions were many times not what were desired by the commanders. The positions did not adequately account for the size of the dispersed tank platoon; did not always account for line-of-sight visibility required for their direct-fire weapons; and in some cases did not utilize terrain properly.

- **Lesson Learned #3**

Enhance the battle position algorithm for future experiments.

- **Observation #4**

The DA GUI, originally developed for aviation operations was easily adapted for acceptable operation by tank commanders.

- **Discussion #4**

No significant code changes were made to the GUI developed on the RPA program. Instead, primarily data files were modified to change the legends for controls and symbols. In addition some features not required for DIFM were just disabled. This is not to imply that other, more intrusive modifications would not improve operator acceptance of the GUI.

- **Lesson Learned #4**

Not expending effort to significantly modify the RPA GUI for DIFM was a good decision for this first experiment with DIFM DA technology.

- **Observation #5**

Methods of handling special terrain features like trees need to be addressed in future experiments during the computation of line-of-sight.

- **Discussion #5**

The RPA DA software does not consider terrain features like trees when computing exposure of one position to another. RPA took this approach since at altitude terrain feature are often less a factor; aviation sensors can many times see through the terrain (RF, IR); and currently available databases do not represent terrain features like trees with much accuracy. However, for ground combat terrain features like tree lines are much more important.

- **Lesson Learned #5**

Develop method(s) for considering line-of-sight blockage by terrain features like trees and evaluate in future experiments.

6. Conclusion

The DIFM was a technically complex effort that achieved its goal. The successful integration of multiple GFE software models into the MWTB hardware provided the desired synthetic environment for the customers. This environment allowed them to analyze and evaluate the resulting data to assist in developing better force protection, increased survivability, and enhanced command and control procedures. Combined, these enhancements will better preserve the force in combat operations. A follow-on to this effort is currently planned for July-August 1999.

7. Points of Contact

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Acronym List

AAN	Army After Next
AAR	After Action Review
ADST	Advanced Distributed Simulation Technology
ARPA	Advanced Research Projects Agency
ARSI	ARPA Reconfigurable Simulator Initiative
BLOS	Beyond Line of Sight
BLUFOR	Blue Forces
CDRL	Contract Data Requirements List
CEP	Concept Evaluation Program
CRP	Common Relevant Picture
CTDB	Compact Terrain Database
DA	Decision Aid
DMA	Defense Mapping Agency
DO	Delivery Order
DIFM	Distributed Interactive Fire Mission
DIS	Distributed Interactive Simulation
FBCB2	Force XXI Battle Command Brigade and Below
FM	Frequency Modulation
FRAGO	Fragmentary Order
GFE	Government Furnished Equipment
GUI	Graphical User Interface
LAT/LONG	Latitude/Longitude
LAN	Local Area Network
LI	Limit Indicator
LMC	Lockheed Martin Corporation
LMFS	Lockheed Martin Federal Service
LMSG	Lockheed Martin Service Group
ModSAF	Modular Semi-Automated Forces
MMBL	Mounted Maneuver Battle Lab
MTC	Movement to Contact
MWTB	Mounted Warfare Test Bed
OC	Observer Controller
OPFOR	Opposing Forces

OPORD	Operations Order
PC	Personnel Computer
PDU	Protocol Data Unit
PM	Program Manager
POC	Point of Contact
PVD	Plan View Display
RPA	Rotorcraft Pilot's Associate
RTSMP	Real-Time Symmetric Multiprocessor
SAF	Semi-Automated Forces
SME	Subject Matter Expert
SOW	Statement of Work
STOW-E	Synthetic Theater of War-Europe
STRICOM	(US Army) Simulation Training and Instrumentation Command
TC	Tank Commander
TIM	Technical Interchange Meeting
TRR	Test Readiness Review
TTP	Tactics, Techniques, and Procedures
UDP	User Datagram Protocol
UFD	User Functional Description
UTM	Universal Transverse Mercator
VDD	Version Description Document